# Drought in Central New York

## Looking back to look ahead.

Jim Brewster, Service Hydrologist
National Weather Service – Binghamton

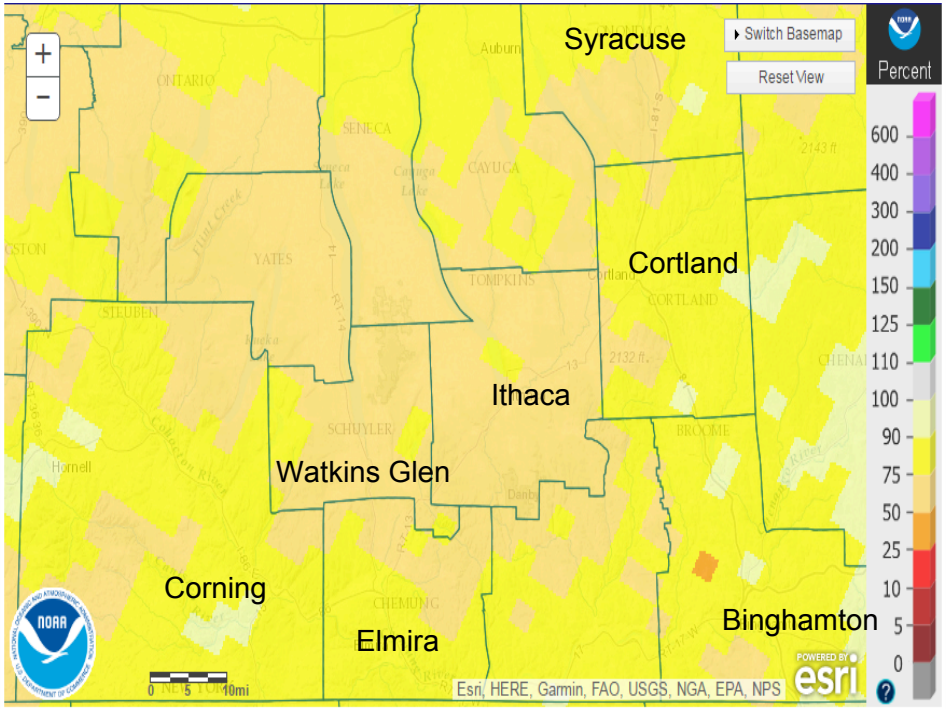
Northeast Drought Assessment Meeting
Cornell University
February 27, 2017

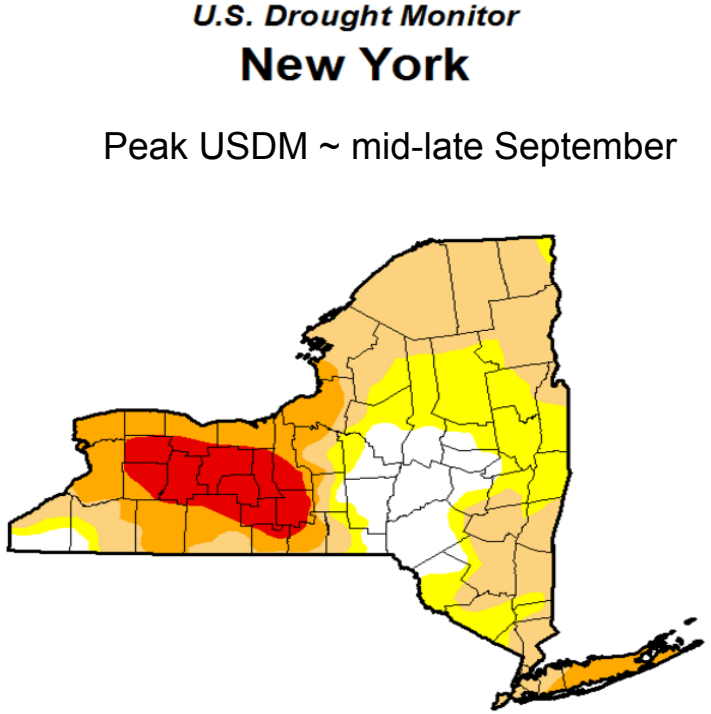
Drought conditions at the Cannonsville Reservoir, Delaware County, NY, Dec. 2001

Credit: DEP

# Drought in History

# The Drought During Water Year 2016.




Peak USDM ~ mid-late September

# Historical Droughts

1930-1935

1956-1957

1961-1965*

1995

1999

2001-2002

2016

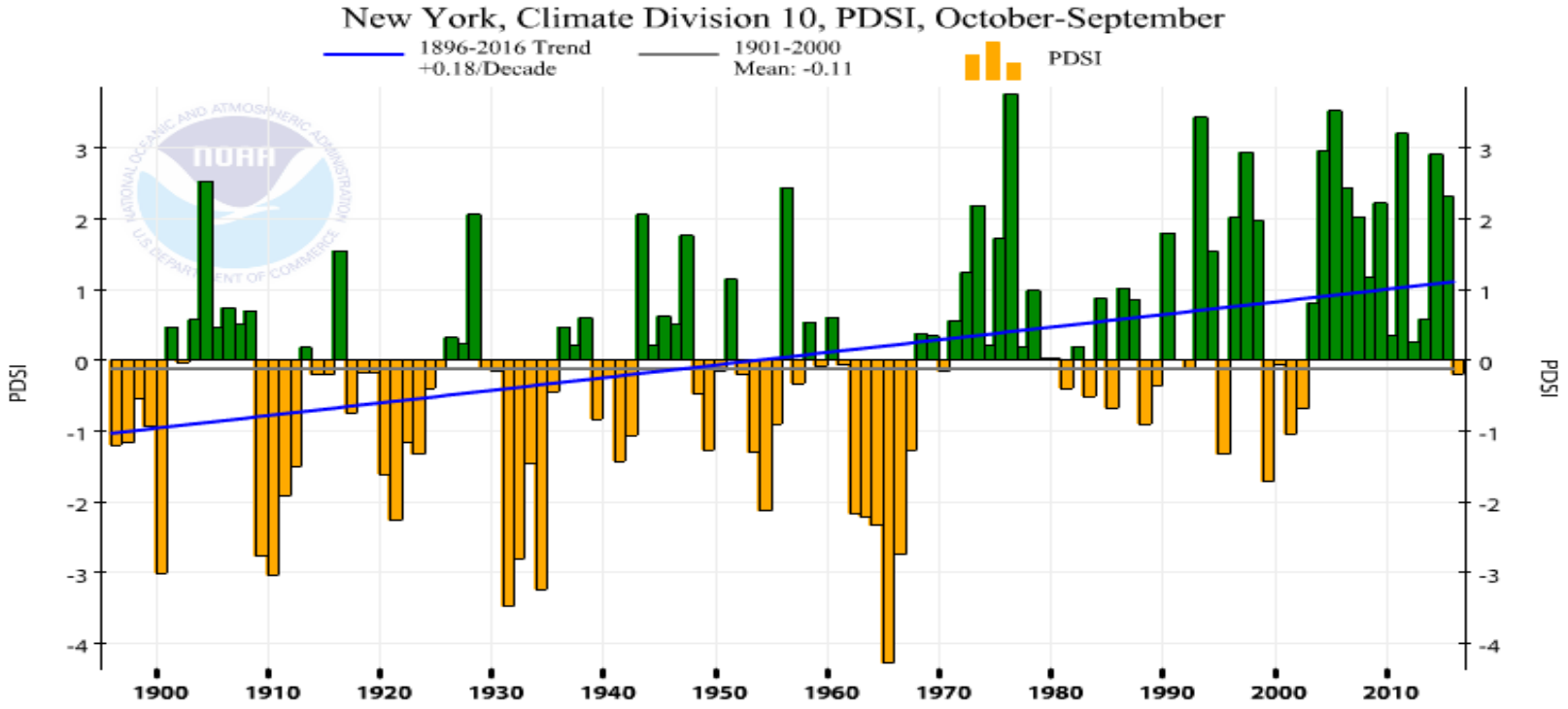
*Central Lakes - Climate Division 10*

| Drought Periods | Duration | Lowest PDSI |
|---|---|---|
| 1899-08 to 1899-12 | 5 months | -3.96 in 1899-11 |
| 1900-08 to 1900-10 | 3 months | -4.3 in 1900-09 |
| 1908-11 to 1909-01 | 3 months | -3.93 in 1908-12 |
| 1909-10 to 1910-01 | 4 months | -4.44 in 1909-12 |
| 1910-03 to 1910-04 | 2 months | -3.66 in 1910-03 |
| 1917-03 to 1917-04 | 2 months | -3.19 in 1917-04 |
| 1921-06 to 1921-10 | 5 months | -3.84 in 1921-10 |
| 1930-11 to 1931-04 | 6 months | -4.6 in 1931-02 |
| 1931-08 to 1932-02 | 7 months | -4.62 in 1931-12 |
| 1934-05 to 1934-12 | 8 months | -4.41 in 1934-12 |
| 1936-08 to 1936-09 | 2 months | -3.3 in 1936-09 |
| 1939-11 to 1940-01 | 3 months | -4.04 in 1940-01 |
| 1941-11 to 1942-01 | 3 months | -3.9 in 1942-01 |
| 1949-11 to 1949-12 | 2 months | -3.72 in 1949-12 |
| 1953-12 to 1954-01 | 2 months | -3.29 in 1953-12 |
| 1960-12 to 1961-01 | 2 months | -4.51 in 1961-01 |
| 1964-09 to 1965-12 | 16 months | -4.81 in 1965-08 |
| 1991-11 to 1991-12 | 2 months | -3.05 in 1991-11 |
| 1995-08 to 1995-09 | 2 months | -3.33 in 1995-08 |
| 1999-07 to 1999-08 | 2 months | -3.13 in 1999-07 |

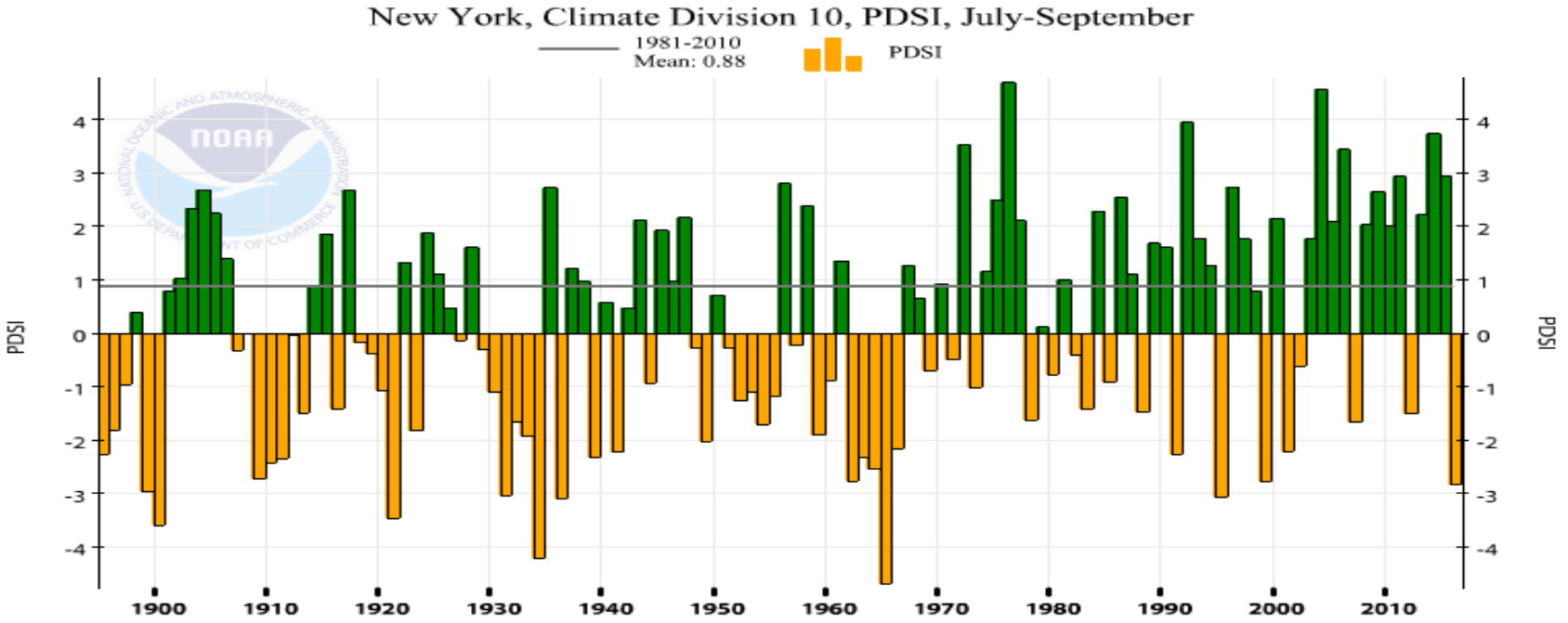
**Prior to 1950, 71% of severe-extreme droughts were 3 months or longer.**

**Since 1950, only one occurrence of severe-extreme drought more than 3 months long. Most now are short, 2-3 month droughts (per the PDSI).**

# Palmer Drought Index (Long Term)



# Palmer Drought Index (3-month-warm)

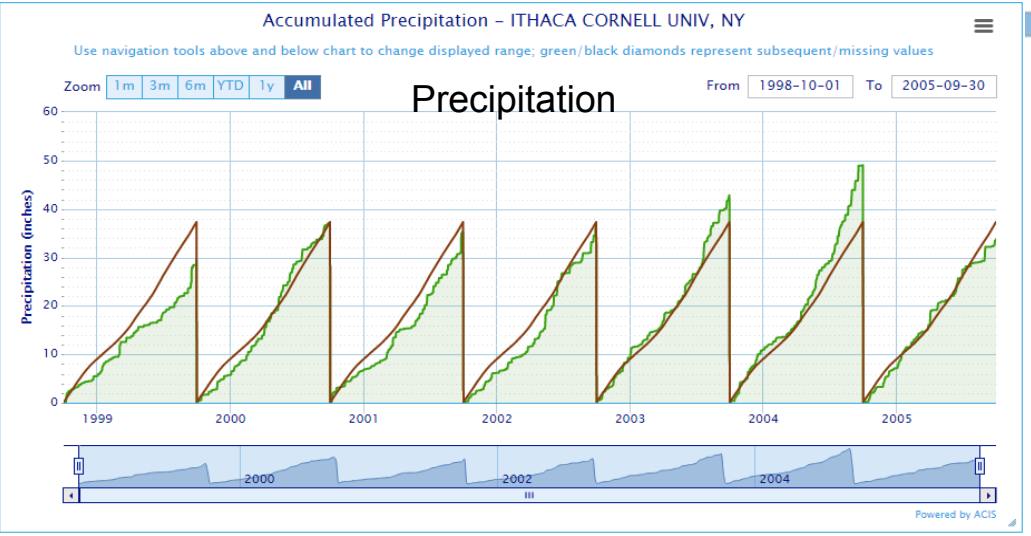


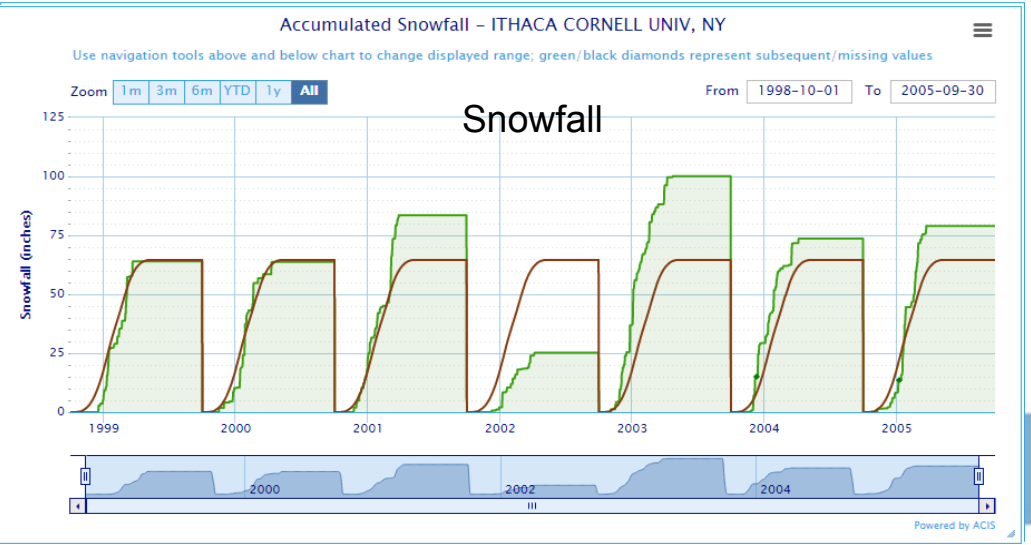
# Climate Tidbits During Drought


- Drought-like periods are not rare. (About a 10-year frequency).
- *Extreme and extended* drought periods are increasingly rare.
- Worst drought period in recorded history was the mid 1960s.
- The early-mid 1930s were a close 2nd.

- Normal annual (WY) precipitation is 35 to 45 inches.
- Worst droughts were 65-75% of normal precipitation.
- Post-1970 droughts were 70-95% of normal precipitation.

- Snowfall during droughts: 35% to 130% of normal.
- Greatest snow amounts were during the cold 1960s, 1990s were transitional, and 2000s-2010s generally milder with less snow.




# Ponderings

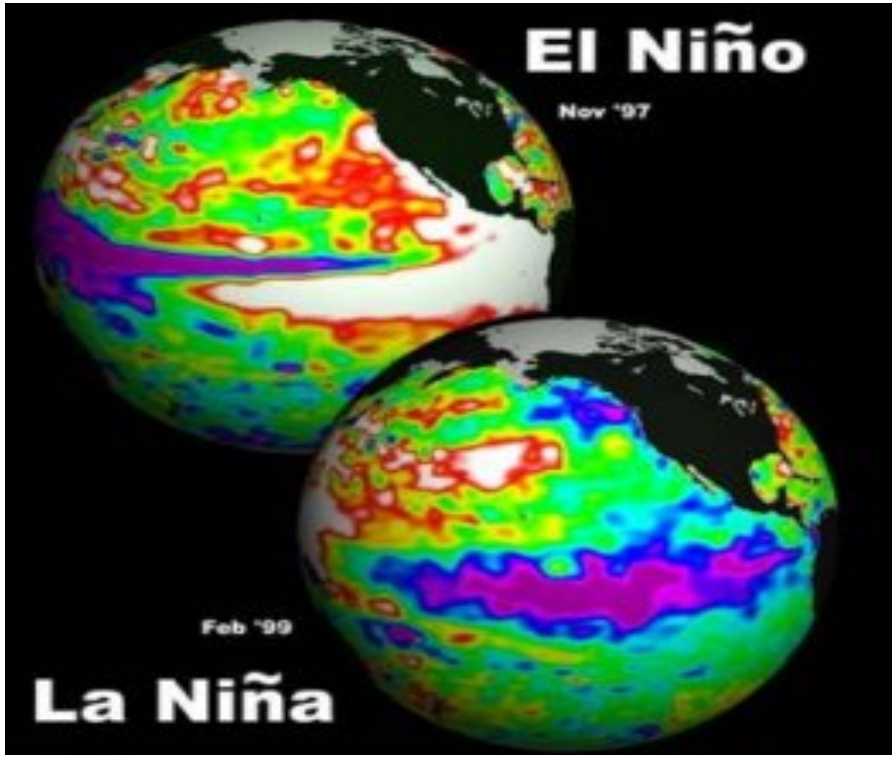
- Are there any observed patterns leading into wet period droughts?
- Can we rely on a dry winter as precursor to warm season drought?
- Are there ANY signals?

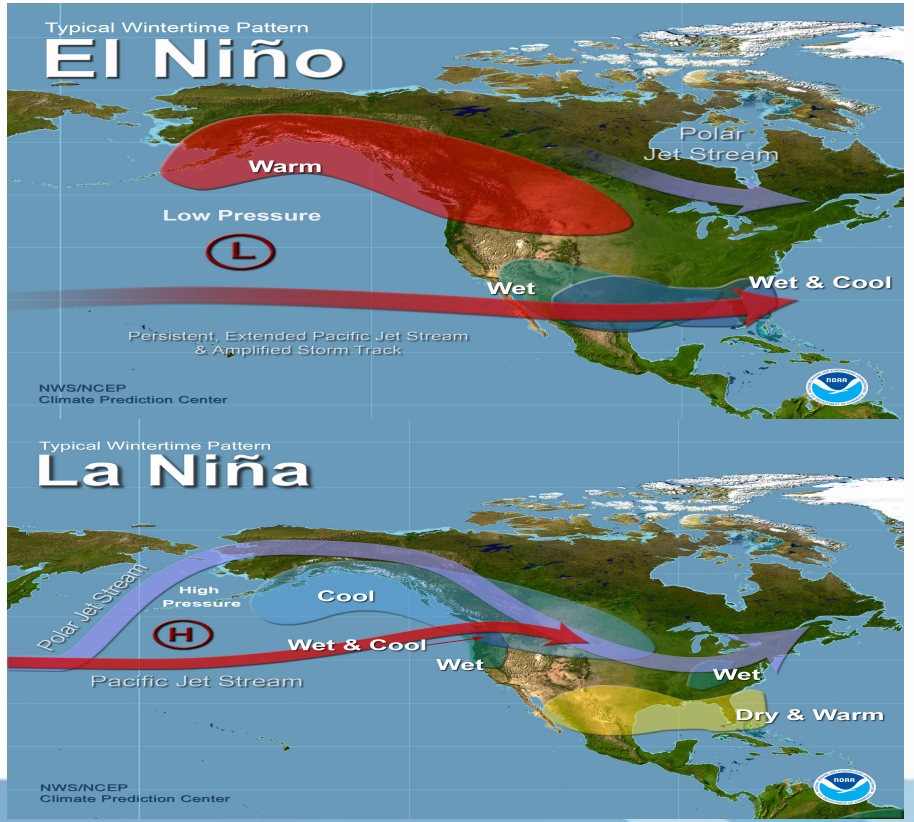
# Atmospheric and Oceanic Patterns Associated with Dryness/Drought

- Seasonal forecasts hinge on long trends of oceanic and atmospheric circulation signals.
- Most are predictable only a few weeks to a month in the future.
- El Nino/Southern Oscillation predictability has some skill, and is the main seasonal driver for U.S. outlooks.
- Not necessarily the Northeast.

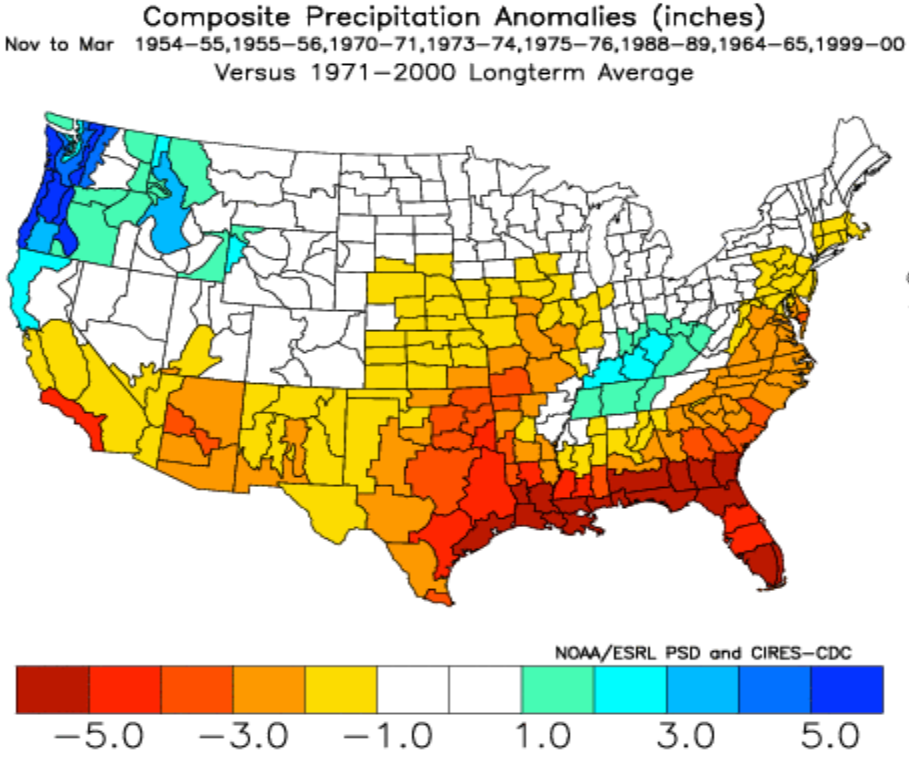
# Seasonal Forecasting – Scientific “Shot in the Dark”

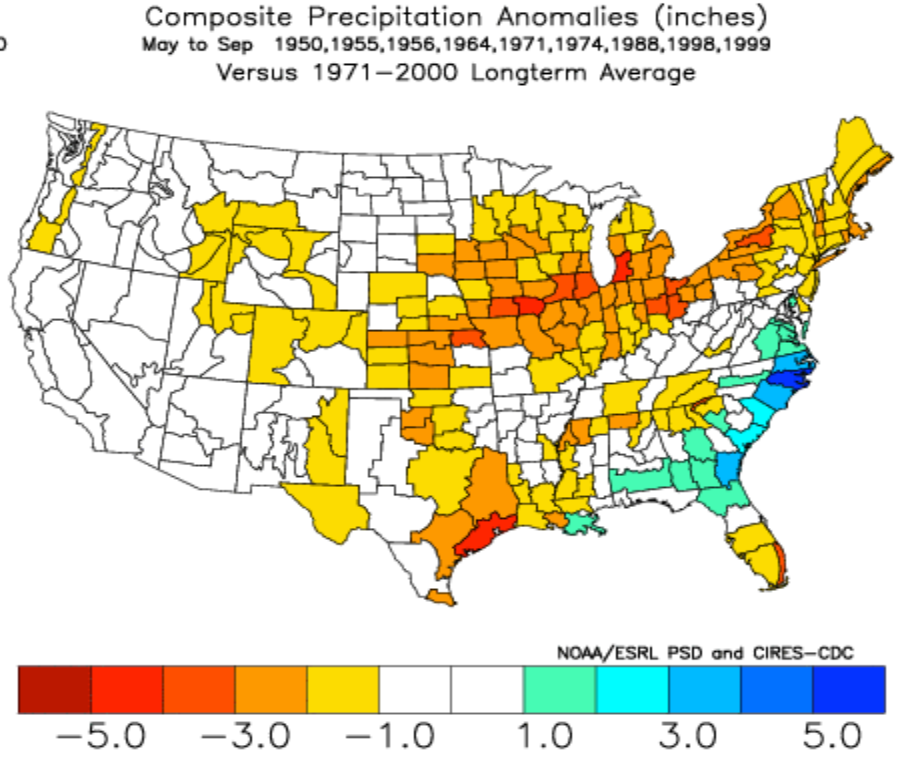
# ENSO Cycles – CPC's Biggest Driving Force in Seasonal Forecasting



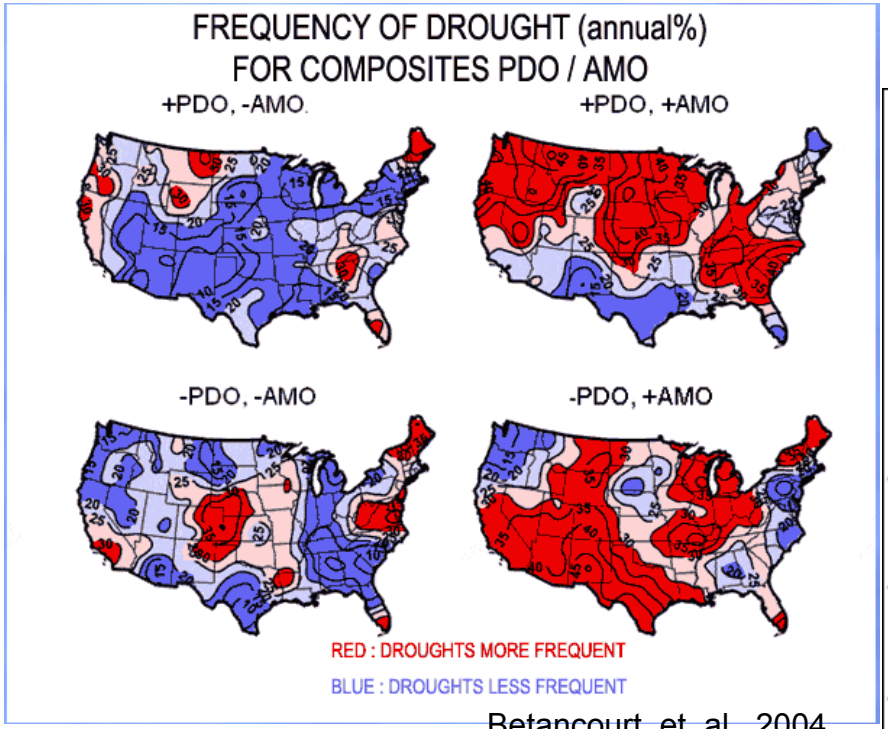



# La Nina: Winter and Summer Anomalies

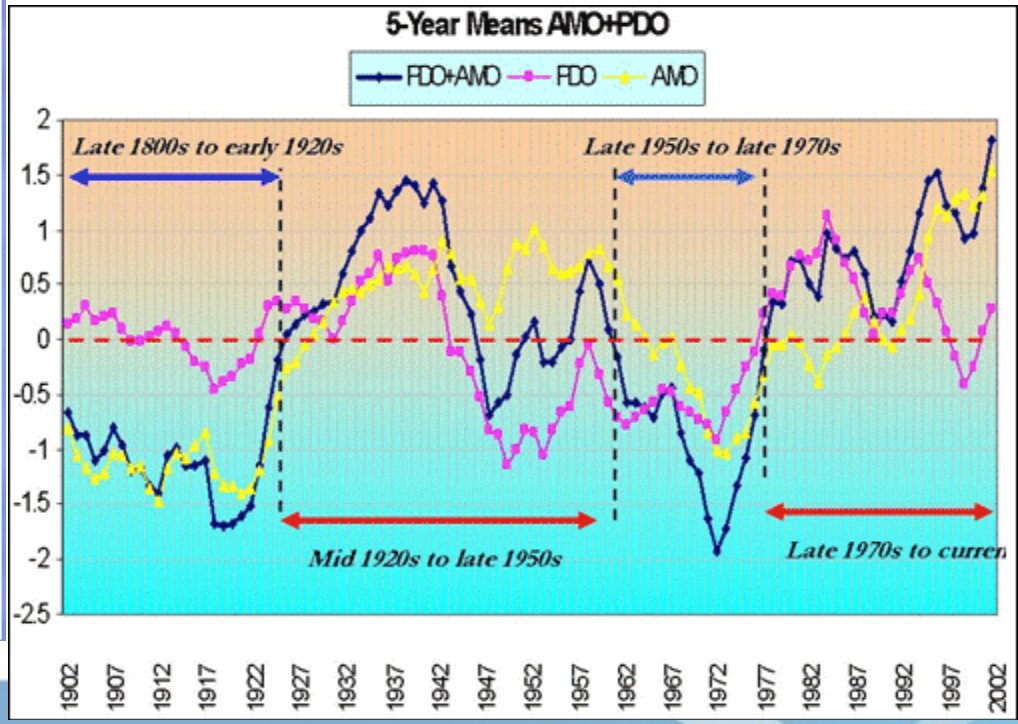


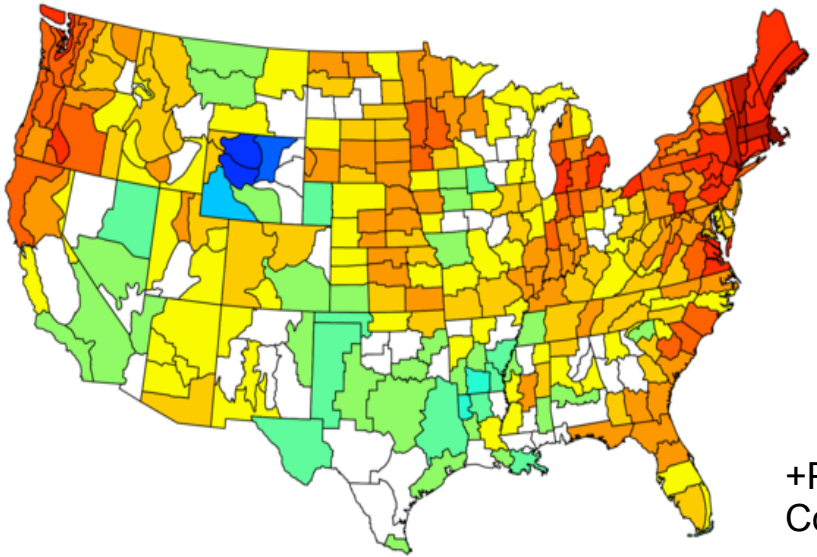
# A Look At Other Ocean Signals




Betancourt, et. al., 2004



NOAA/NCDC Climate Division Composite Standardized Precipitation Anomalies
Oct to Mar 1928–29 to 1947–48
Versus 1951–2010 Longterm Average

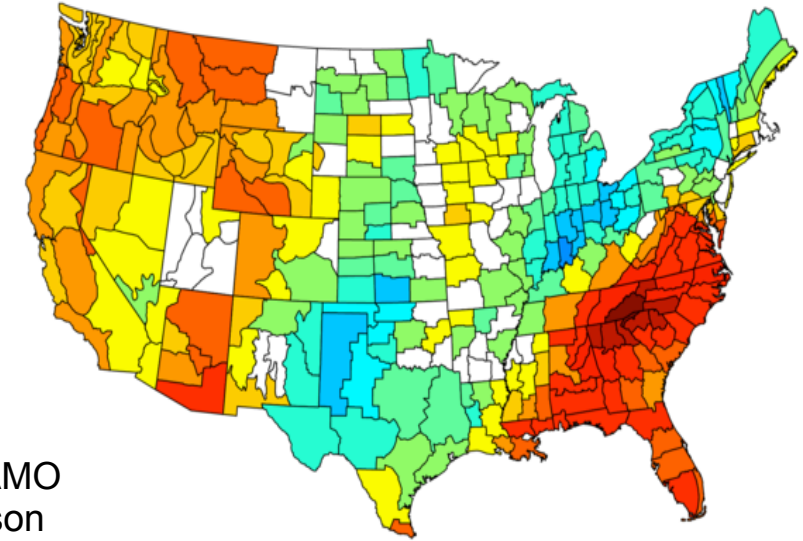


NOAA/ESRL PSD and CIRES–CU

−0.75 −0.55 −0.35 −0.15 0.05 0.25 0.45 0.65

+PDO, +AMO
Cool Season

NOAA/NCDC Climate Division Composite Standardized Precipitation Anomalies
Oct to Mar 1999–** to 2008–09
Versus 1951–2010 Longterm Average



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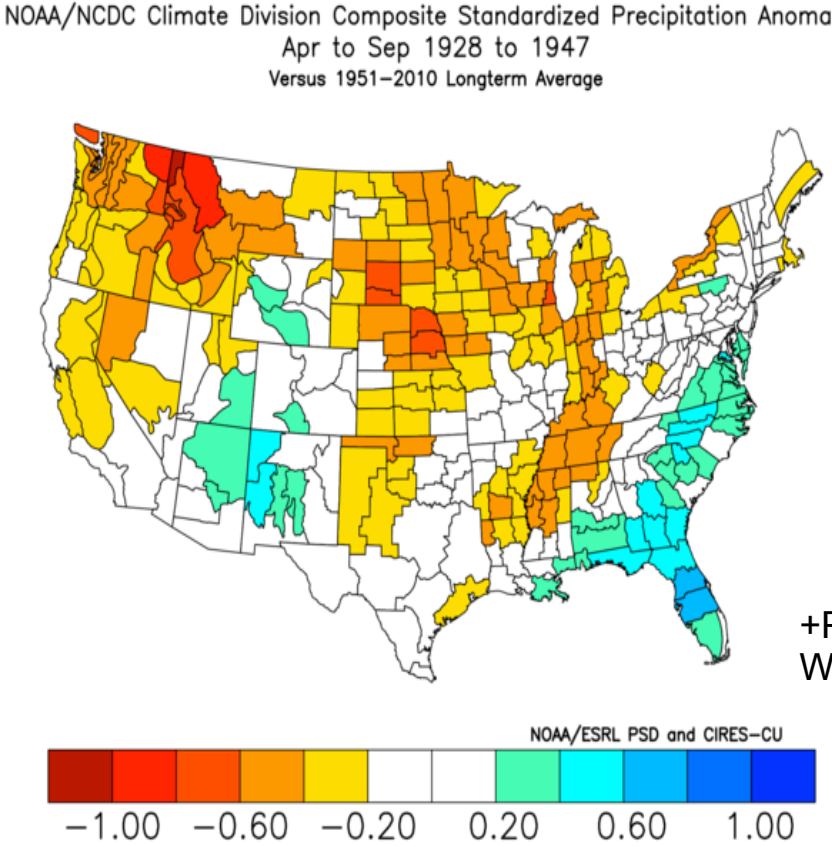
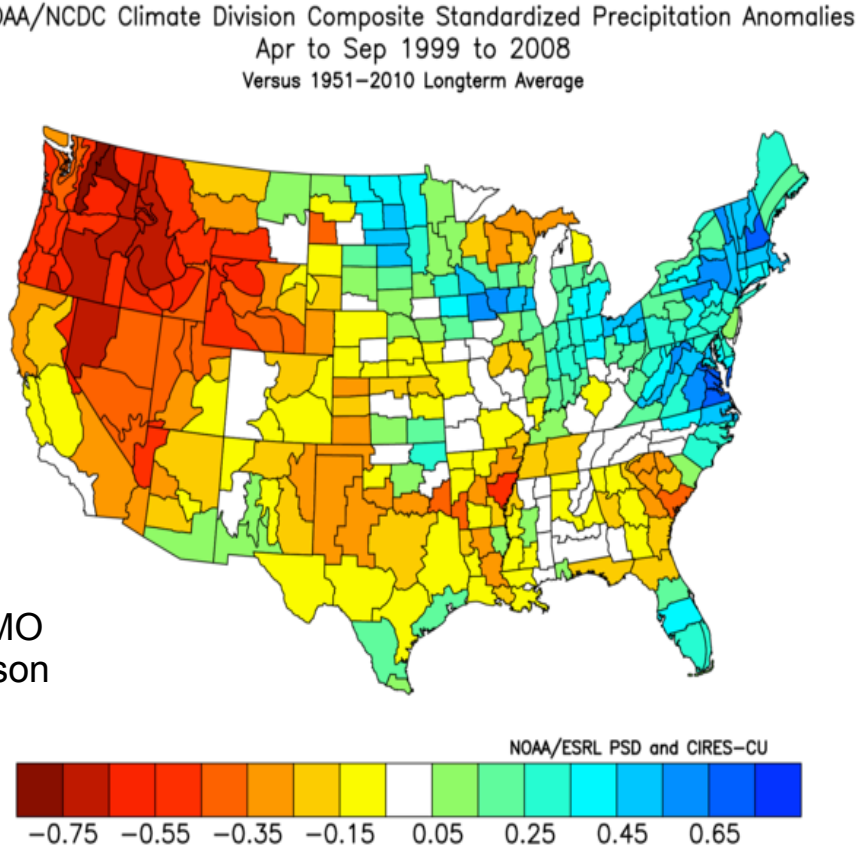
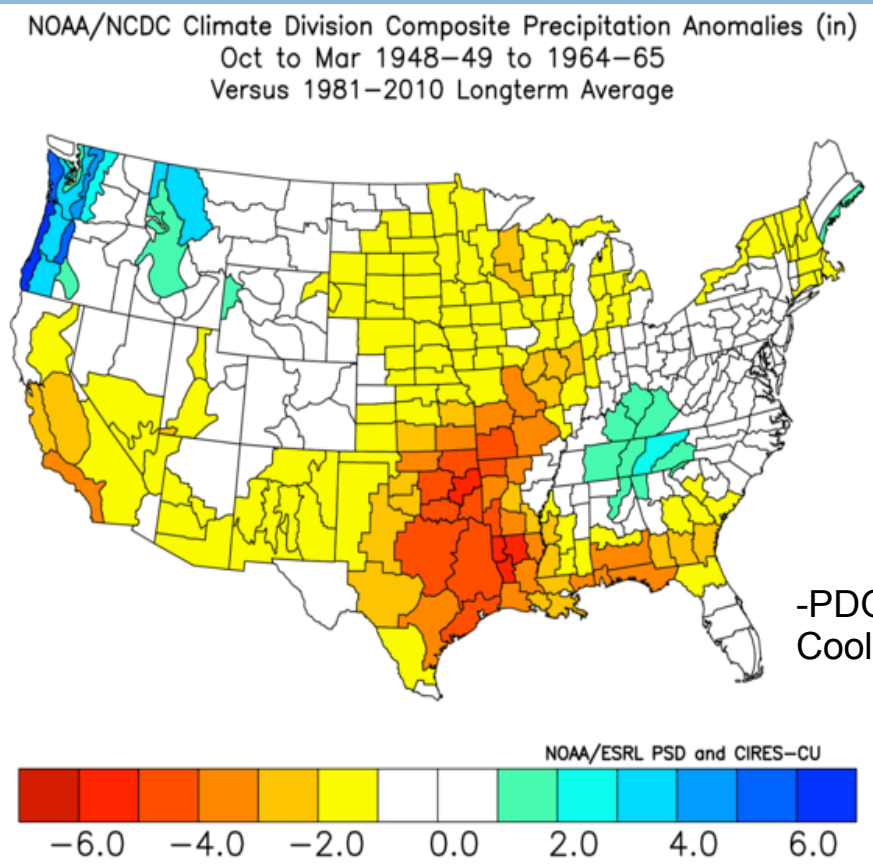
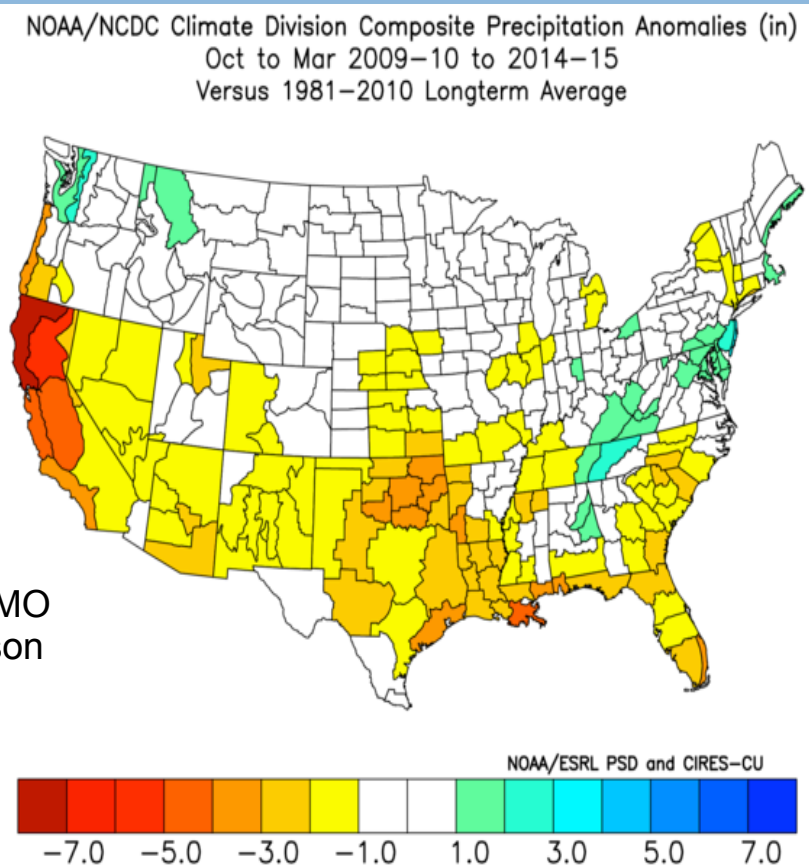


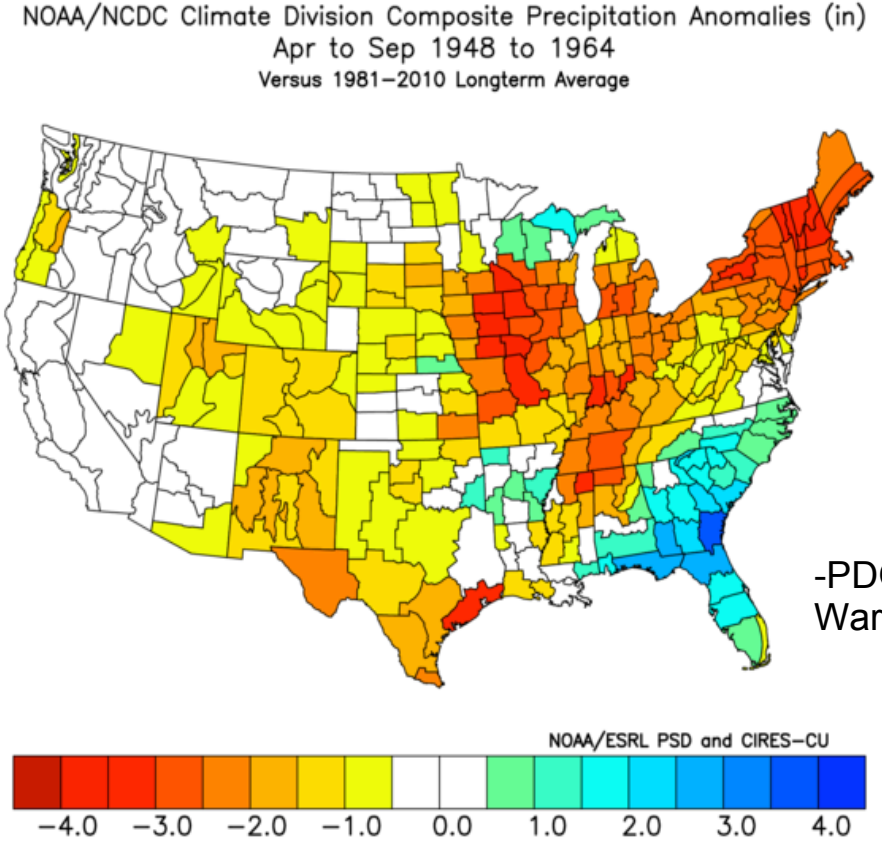

+PDO, +AMO
Warm Season






-PDO, +AMO
Cool Season



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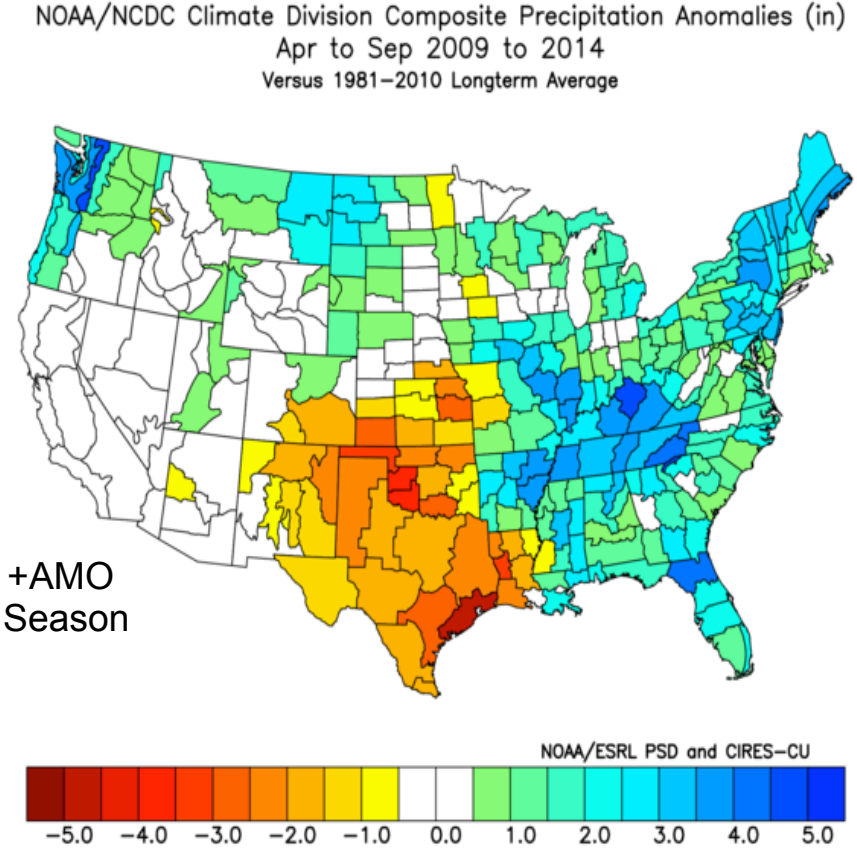
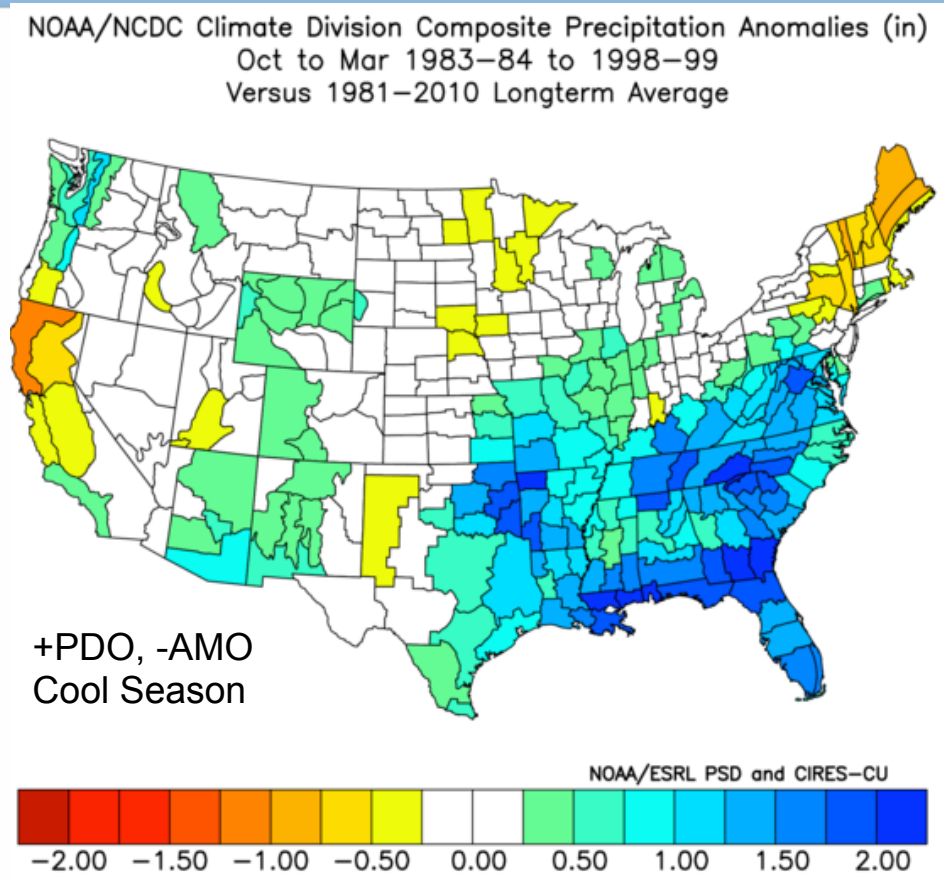
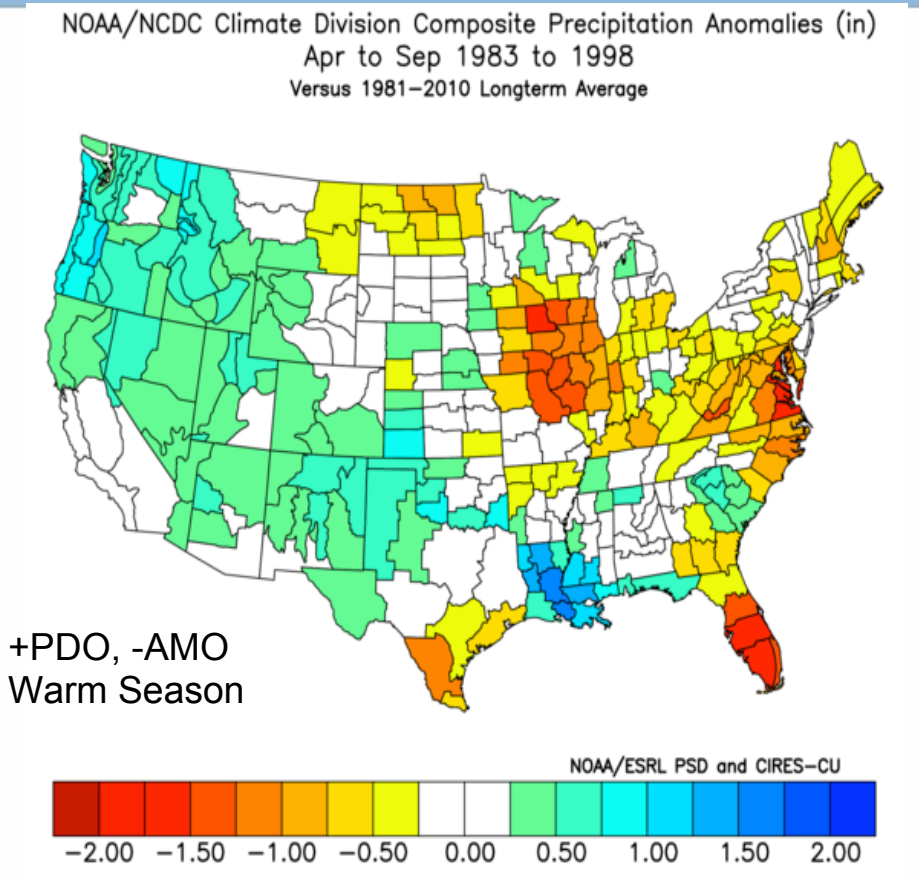
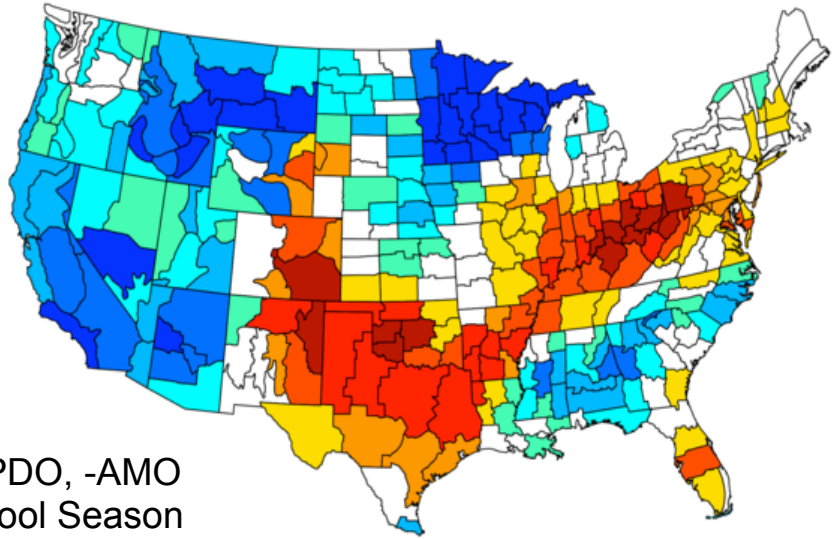
Warm Season




NOAA/NCDC Climate Division Composite Precipitation Anomalies (in)
Oct to Mar 1983–84 to 1998–99
Versus 1981–2010 Longterm Average
+PDO, -AMO
Cool Season
NOAA/ESRL PSD and CIRES–CU
−2.00 −1.50 −1.00 −0.50 0.00 0.50 1.00 1.50 2.00


NOAA/NCDC Climate Division Composite Precipitation Anomalies (in)
Apr to Sep 1983 to 1998
Versus 1981–2010 Longterm Average
+PDO, -AMO
Warm Season
NOAA/ESRL PSD and CIRES–CU
−2.00 −1.50 −1.00 −0.50 0.00 0.50 1.00 1.50 2.00

NOAA/NCDC Climate Division Composite Standardized Precipitation Anomalies
Oct to Mar 1965–66 to 1982–83
Versus 1951–2010 Longterm Average



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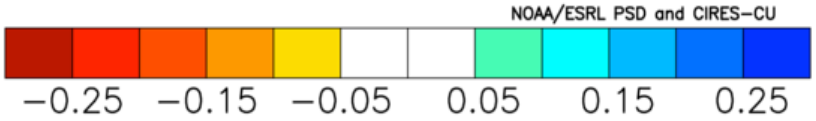
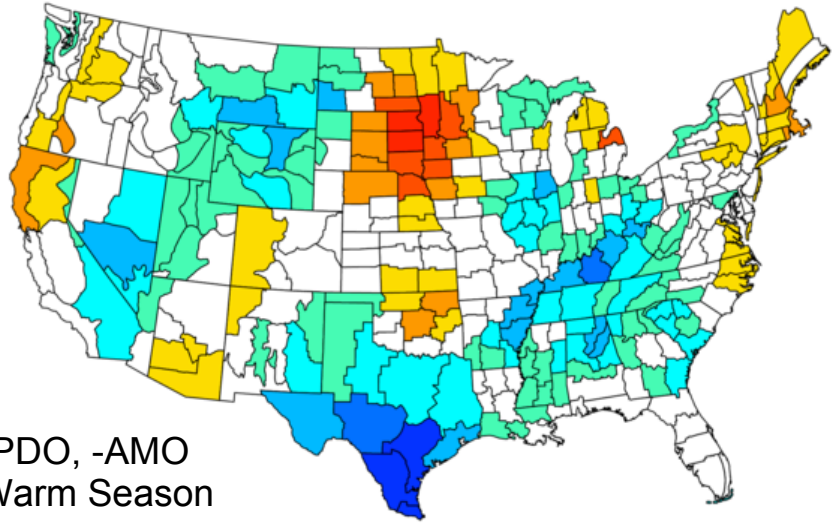
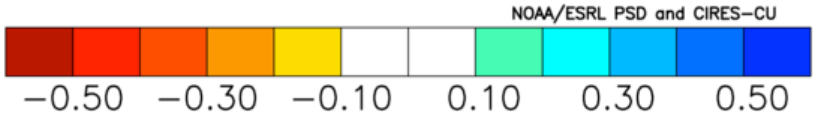
Cool Season



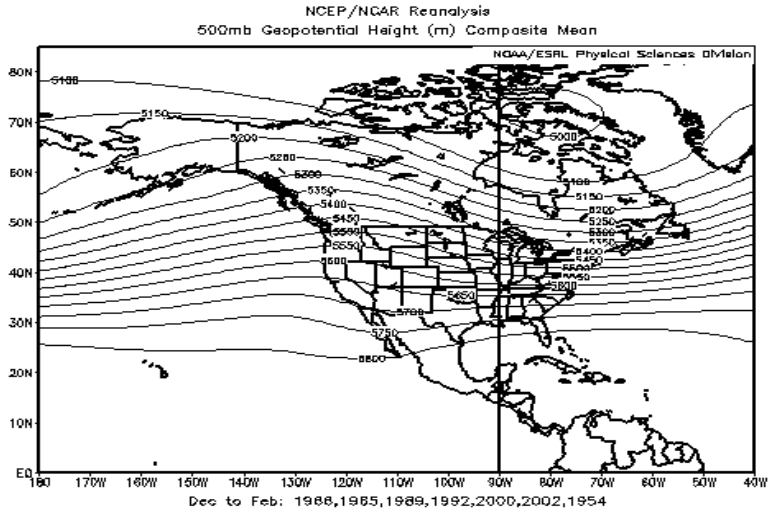

NOAA/NCDC Climate Division Composite Standardized Precipitation Anomalie
Apr to Sep 1965 to 1982
Versus 1951–2010 Longterm Average

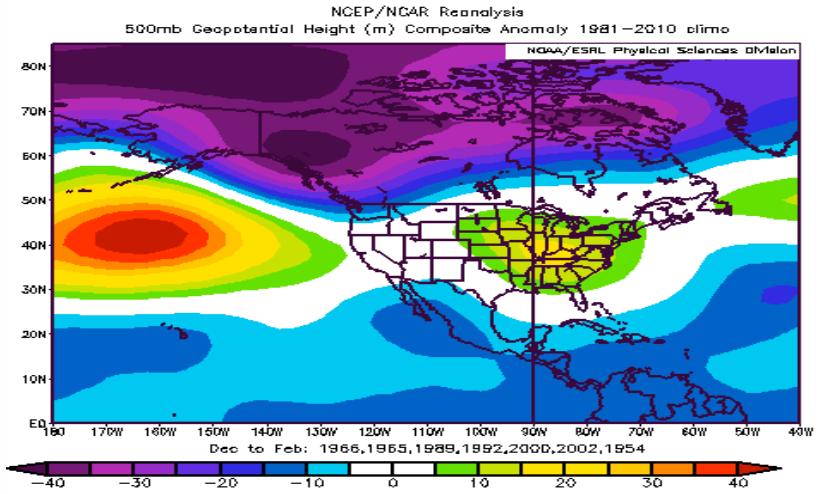


-PDO, -AMO
Warm Season



# Atmospheric Pattern during Dry Winters since 1960




- Cold phase Pacific/North American Oscillation (-PNA) = drier and milder winters.
- Jet streams generally split and track over continental areas with lack of Atlantic and Gulf moisture. Pacific moisture dries up over Rockies. Fewer multi-inch events.
- Lack of Atlantic blocking needed for bigger storms.
- Milder winter curtails Lake Effect Snow contribution.

# Tendency Toward the –PNA Teleconnection

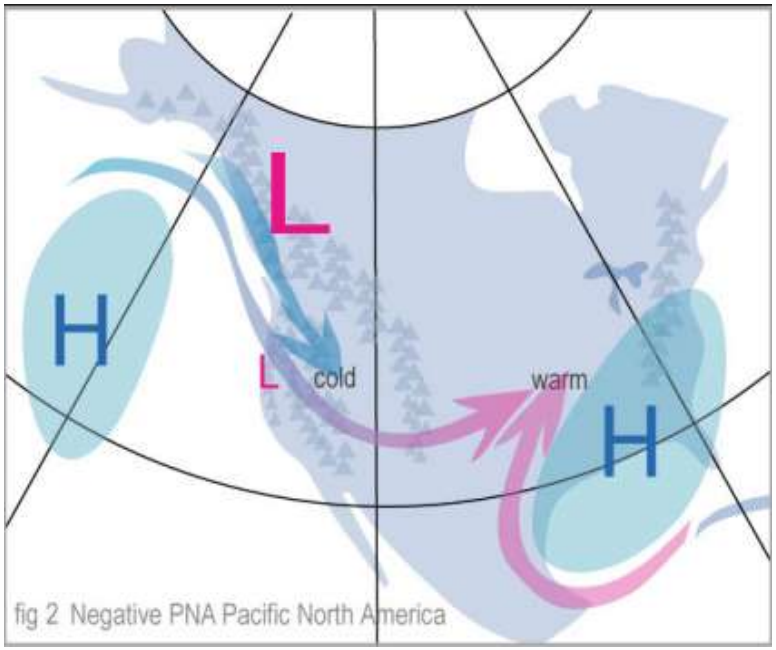
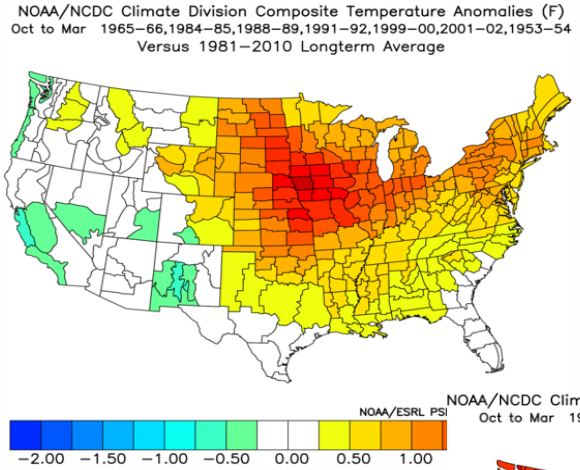
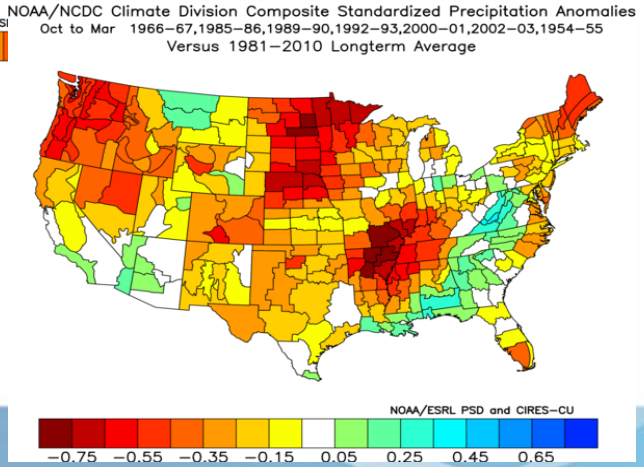


fig 2 Negative PNA Pacific North America

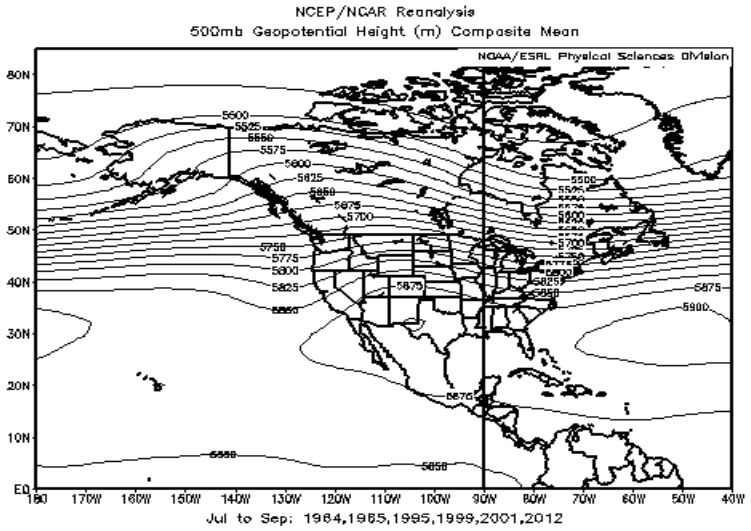


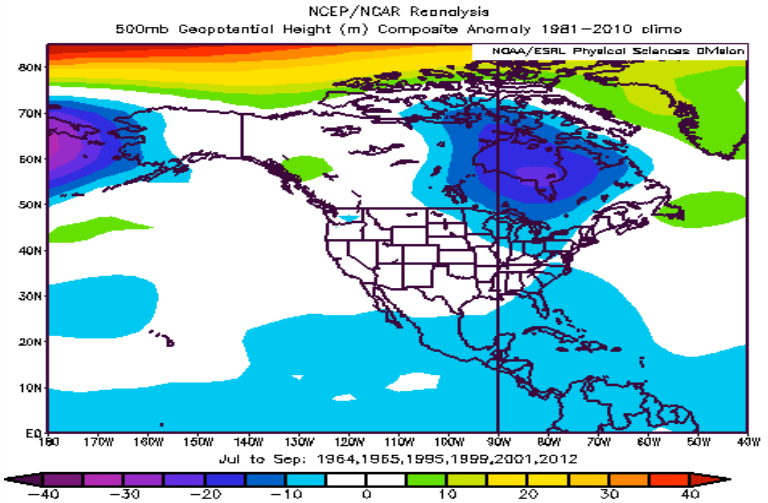

Temperature




Precipitation

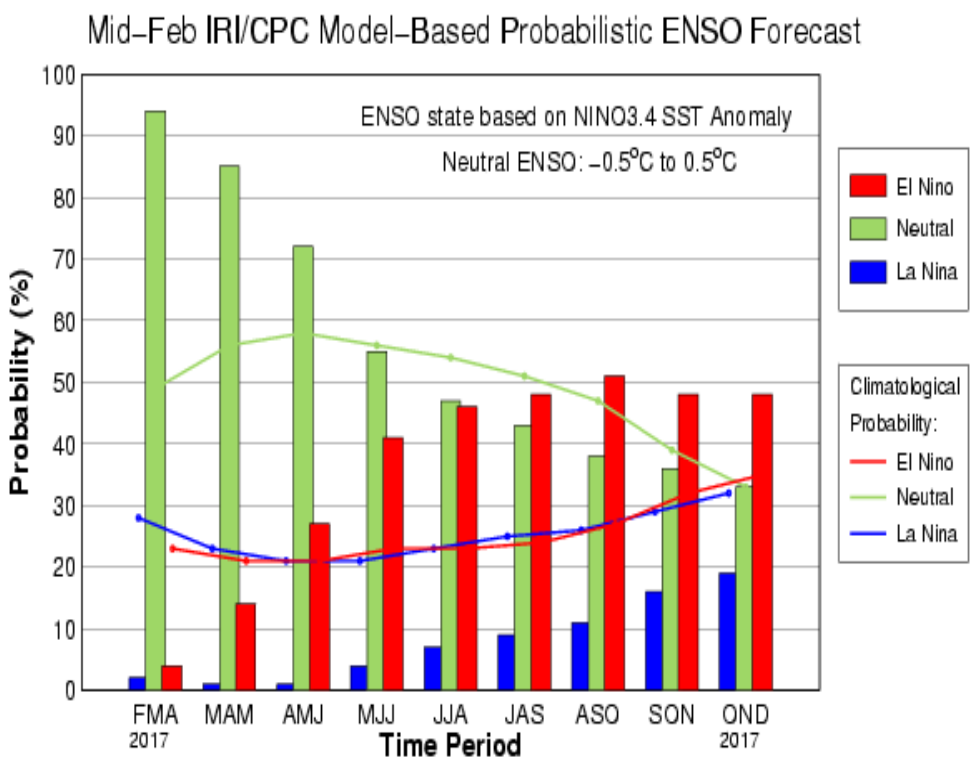
# Atmospheric Pattern during Dry Summers since 1960

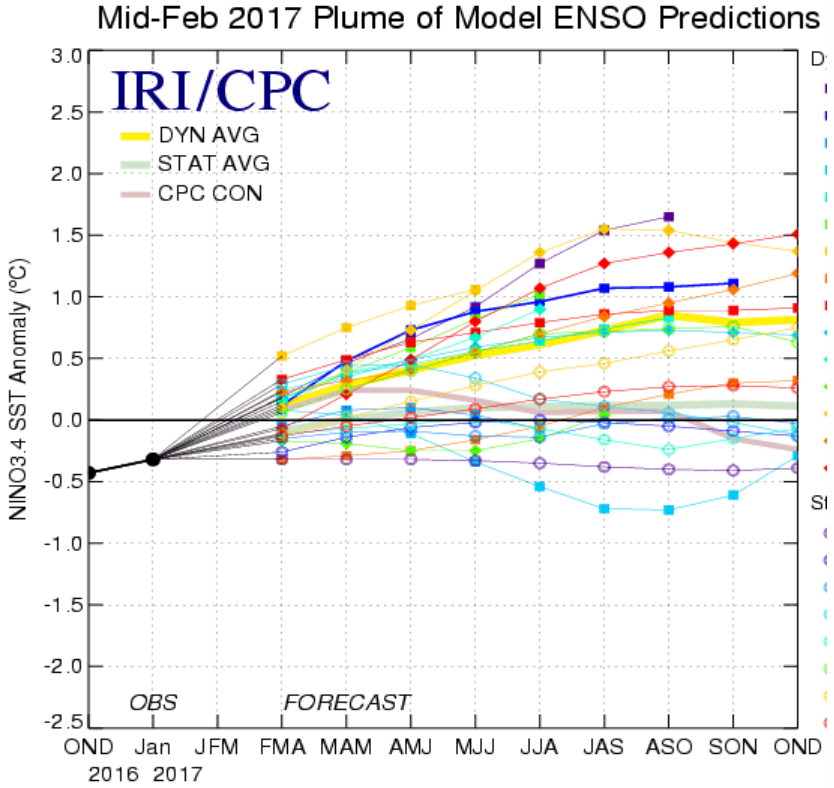


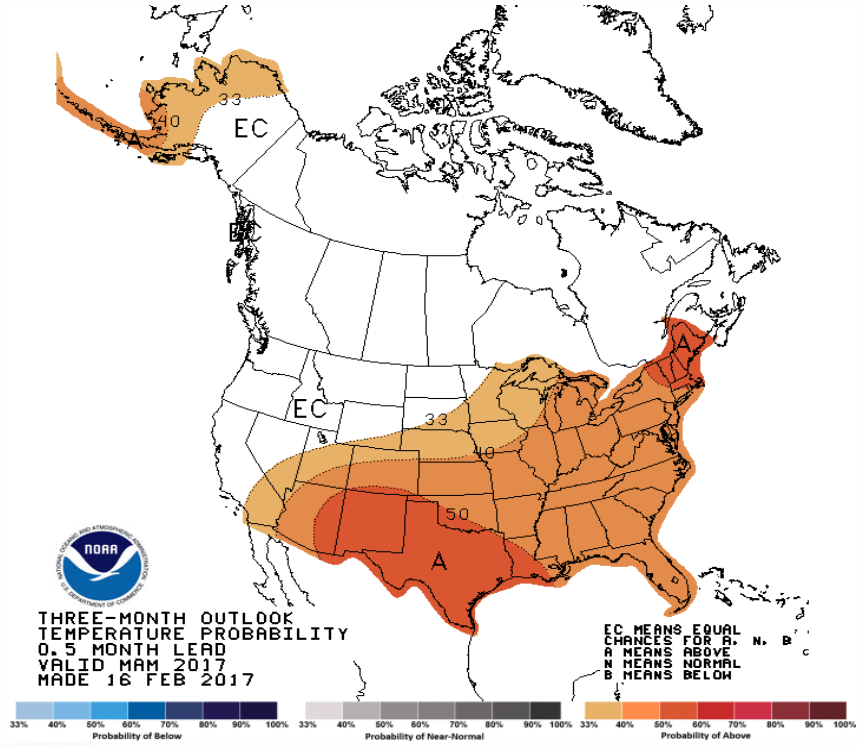

- Signals are generally weaker.
- Lower than average heights over north-east Canada, Great Lakes, New England
- Lower heights favor a drier NW flow across the Northeast.
- Gulf moisture cut off by westward intrusion of Bermuda high across Gulf states.

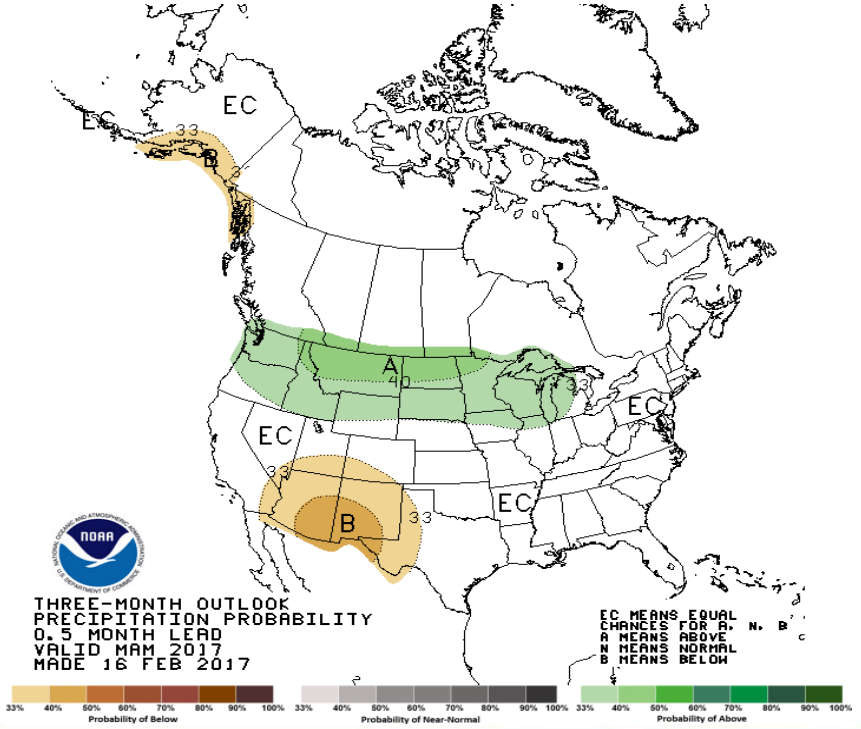
# What Will 2017 Offer?


Mid–Feb IRI/CPC Model–Based Probabilistic ENSO Forecast
ENSO state based on NINO3.4 SST Anomaly
Neutral ENSO: –0.5°C to 0.5°C
El Nino
Neutral
La Nina
Climatological Probability:
El Nino
Neutral
La Nina
Probability (%)
100
90
80
70
60
50
40
30
20
10
0
FMA 2017
MAM
AMJ
MJJ
JJA
JAS
ASO
SON
OND 2017
Time Period

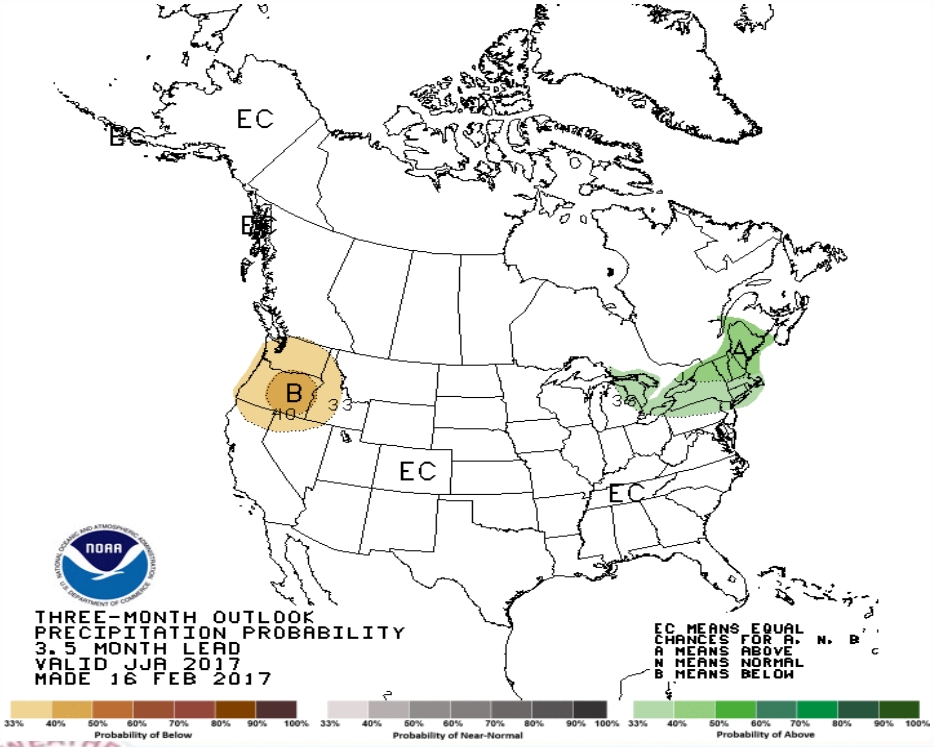

Mid-Feb 2017 Plume of Model ENSO Predictions
IRI/CPC
DYN AVG
STAT AVG
CPC CON
NINO3.4 SST Anomaly (°C)
3.0
2.5
2.0
1.5
1.0
0.5
0.0
-0.5
-1.0
-1.5
-2.0
-2.5
OBS
FORECAST
OND 2016
Jan 2017
JFM
FMA
MAM
AMJ
MJJ
JJA
JAS
ASO
SON
OND

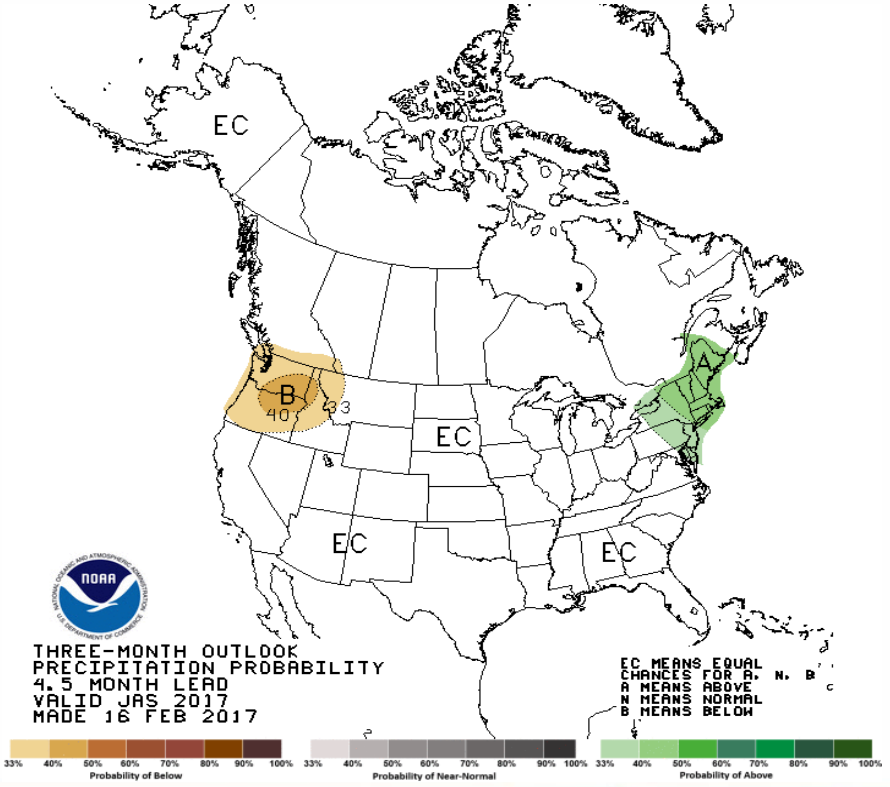
# The Spring Outlook (March-April-May)



# The Summer Outlook – June through September



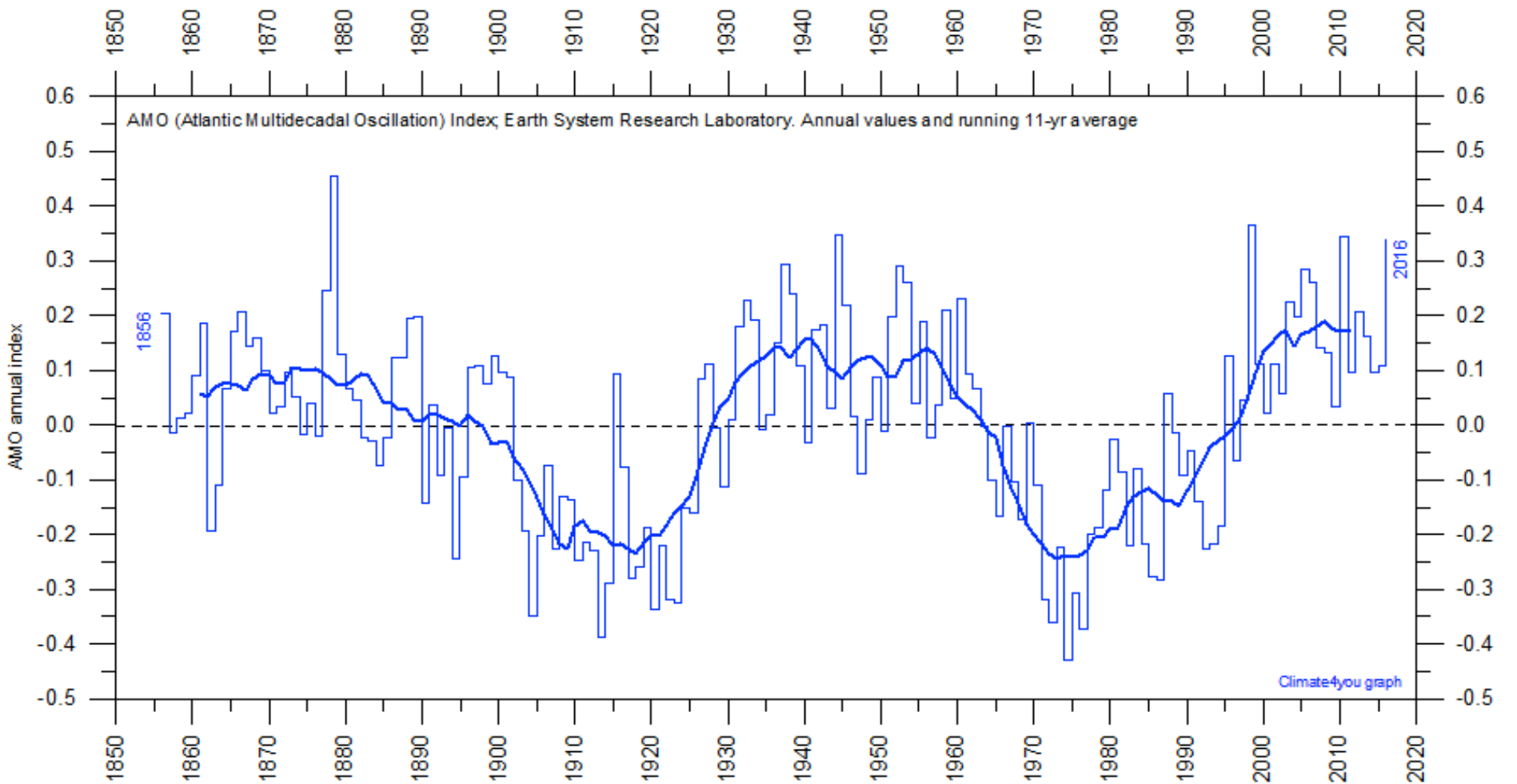
# Final Thoughts

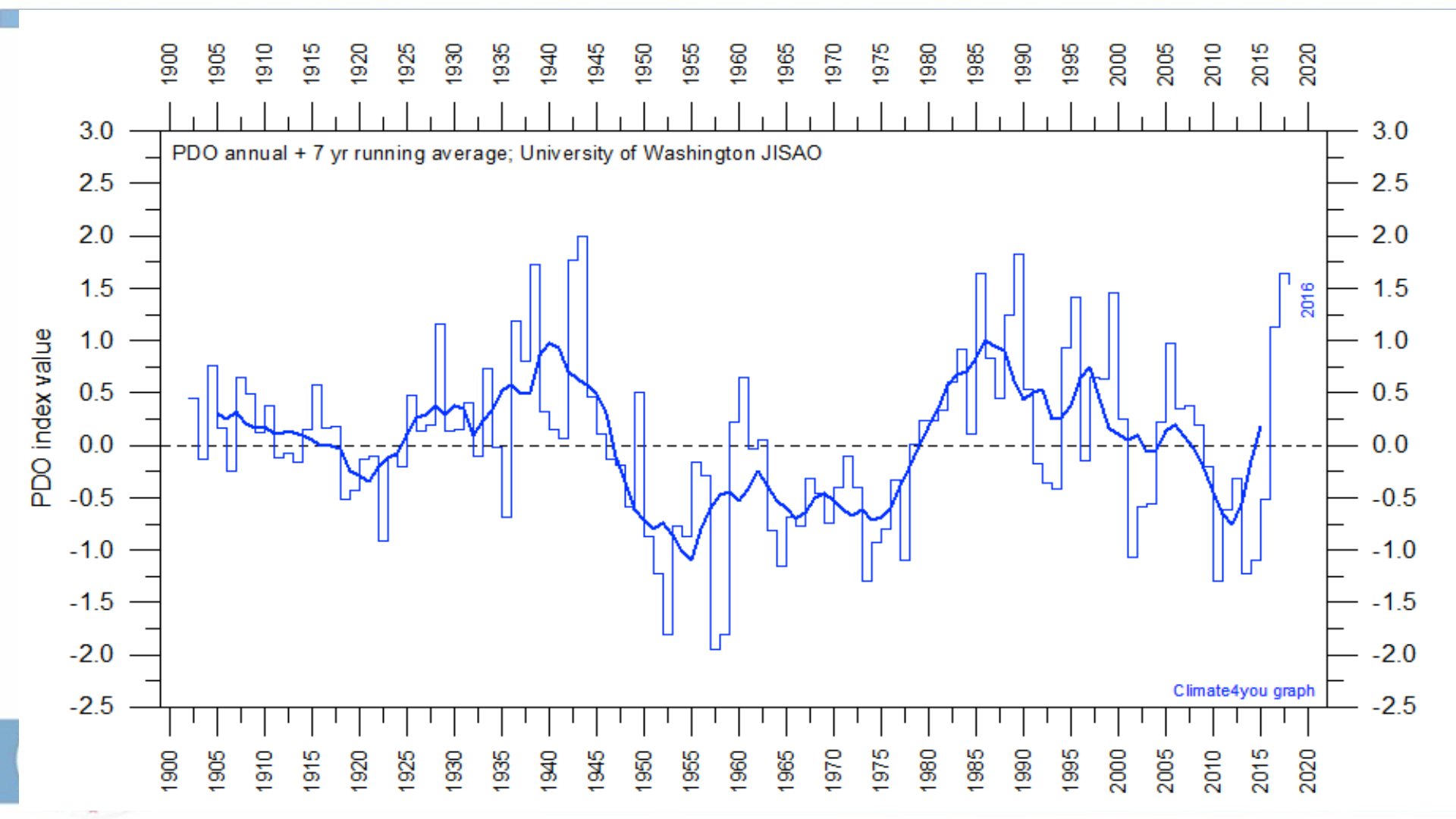
# Droughts End With a Flood…Right?

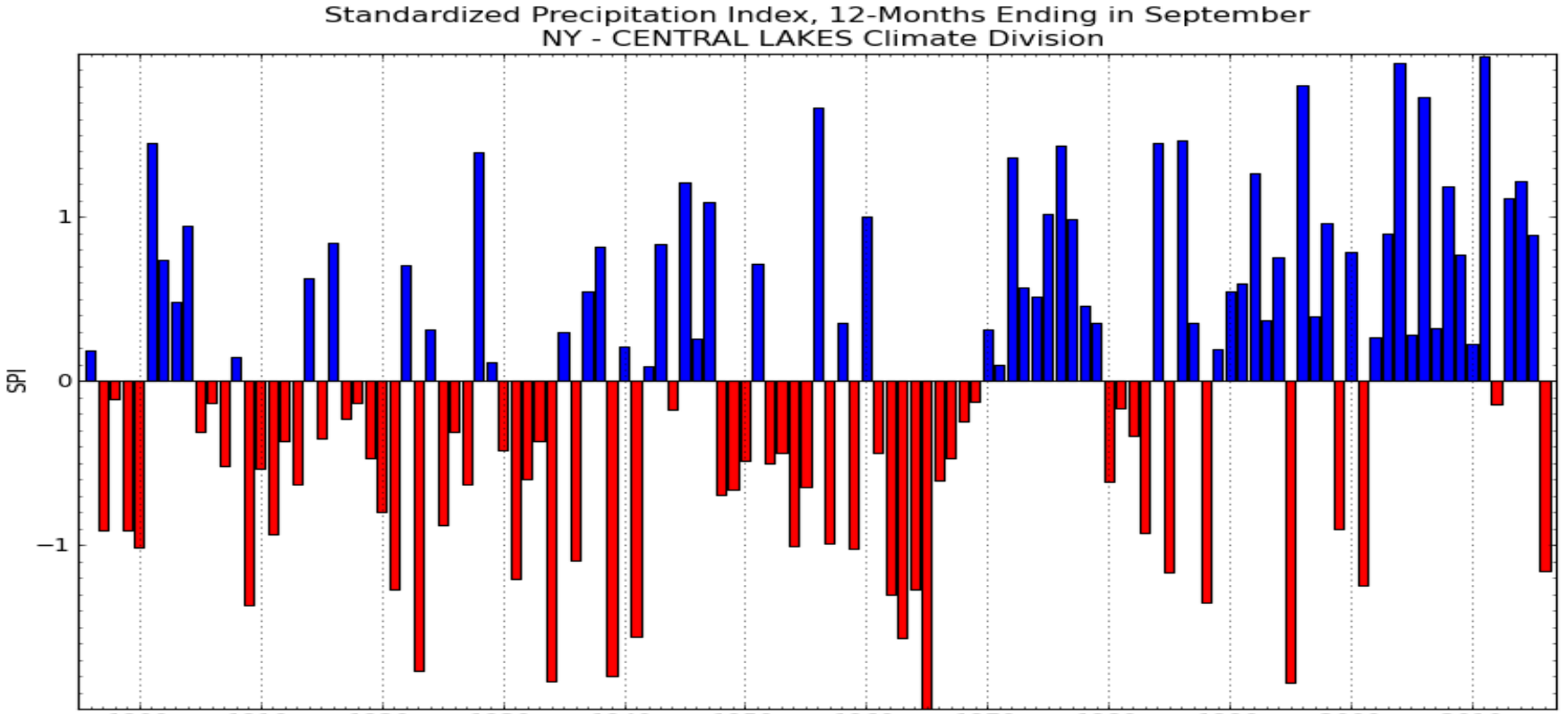
- **Major floods in July 1935 and subsequent major Spring flooding in 1936.**
- **1965 ended gradually with increased snowfall and annual precipitation. Never really came "out" of at least some sort of drought until early '70s. No major floods noted.**
- **1995 drought ended in above normal Fall and Winter precip with a snowmelt flood in January 1996.**
- **2001-2002 drought gradually came out with above normal precipitation in 2003, and was totally busted by the hurricane train in 2004.**
- **2015-2016 came and went in short order, but no flood. Above normal October-November rainfall. Are we really "out", or just in a pause?**

# Conclusions

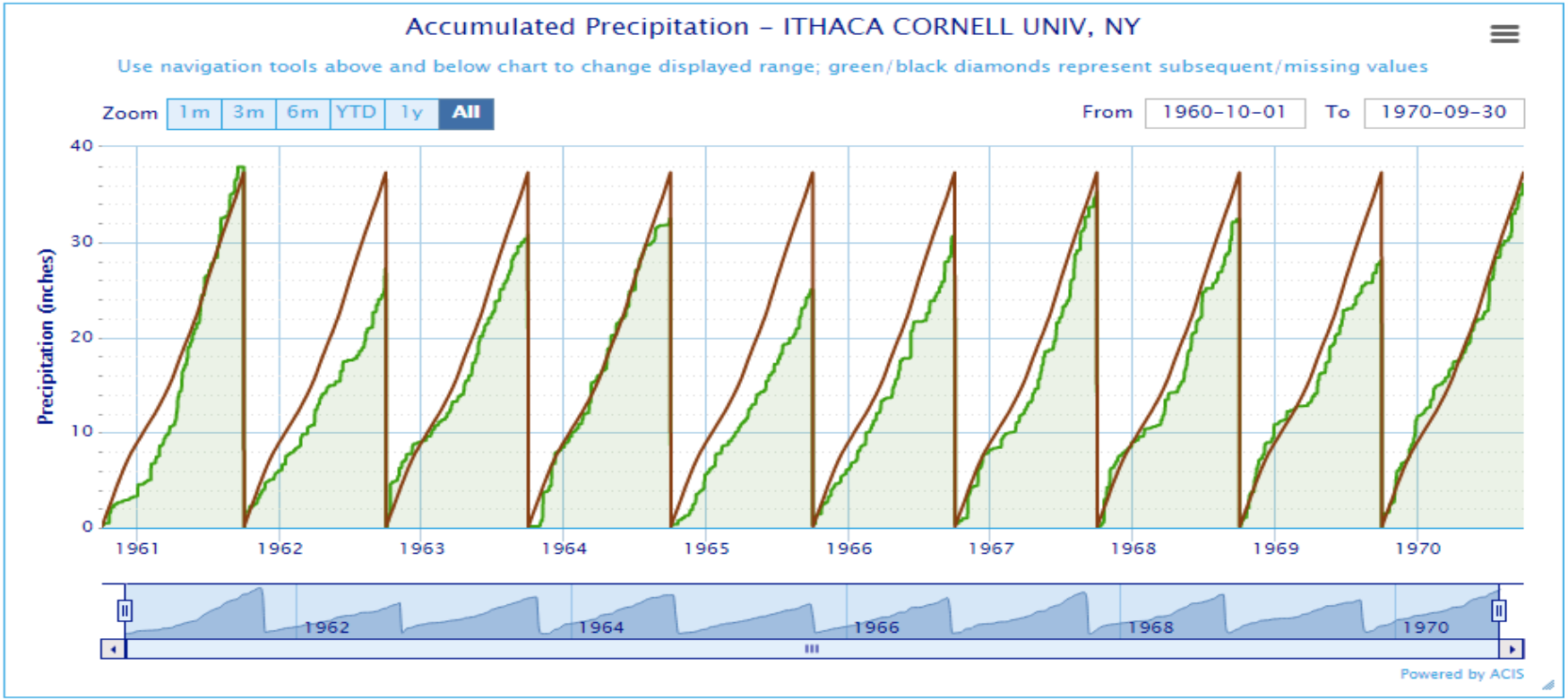
- Drought in Central New York has trended from prolonged multi-month/year events to brief, episodic events. (“Flash Drought”?)
- Seasonal precipitation and snowfall is extremely variable. Tracking patterns is difficult.
- The complexity of the interdependent atmospheric and oceanic circulation signals results in poor correlations to drought prediction.
- Prediction of seasonal temperature and precipitation has marginal skill.
- Future research in oceanic and atmospheric teleconnections is needed.


AMO (Atlantic Multidecadal Oscillation) Index; Earth System Research Laboratory. Annual values and running 11-yr average
AMO annual index
1856
2016
Climate4you graph
1850
1860
1870
1880
1890
1900
1910
1920
1930
1940
1950
1960
1970
1980
1990
2000
2010
2020
0.6
0.5
0.4
0.3
0.2
0.1
0.0
-0.1
-0.2
-0.3
-0.4
-0.5


PDO annual + 7 yr running average; University of Washington JISAO
PDO index value
2016
Climate4you graph
1900
1905
1910
1915
1920
1925
1930
1935
1940
1945
1950
1955
1960
1965
1970
1975
1980
1985
1990
1995
2000
2005
2010
2015
2020
3.0
2.5
2.0
1.5
1.0
0.5
0.0
-0.5
-1.0
-1.5
-2.0
-2.5


Standardized Precipitation Index, 12-Months Ending in September
NY - CENTRAL LAKES Climate Division
SPI
1
0
−1
1900
1910
1920
1930
1940
1950
1960
1970
1980
1990
2000
2010
Data Source: WRCC/UI, Created: 2-24-2017

# Precipitation in the 1960s



# Snowfall in the 1960s